NATIONAL DATA BROADCASTING COMMITTEE

WAVEPHORE TEST RESULTS

NDBC Test Plan ¶	Description	Result
2.1	Net Bit Rate	384 kbps
3.6	Real-Time Delay (Latency)	57 msec
3.7	Acquisition Time (Method 1)	1 sec
3.1.3	Proper Decoding of Closed Captioning	OK
3.5	Program Recordability - BER	
	• Digital Betacam	No data recovery (Loss of sync indication)
	• D2	4.018×10^{-2} (Proponent noted that last eye in active data line was badly distorted.)

NATIONAL DATA BROADCASTING COMMITTEE
WAVEPHORE RECORDABILITY TEST

The method used in this test was as follows:
The video source was passed through the WavePhore encoder with data signal on, and recorded both on a D2 and a Digital Betacam recorder. Expert Observers viewed the output of a professional 20 inch picture monitor, where the A input was the output of the Wavephore encoder and the B input was *either* the playback of the D2 or Digital Betacam recording. The two sources were synchronized to display the same image, and the experts were alternately shown the A input and the B input to the monitor. A series of 10 still and 10 moving video images were viewed in sequence by the Expert Observers, and expert commentary was written.

Expert Observation & Commentary

Date of Test: 12/7/94 Start Time 11:30 AM

Video Images	D2 Recorder	Digital Betacam
Metal Table and Chairs	MONOCHROME SHOTS - NO DISCERNIBLE DIFFERENCE	NO DIFFERENCE
Vines		
Wavy Wall	COLORED FLAT AREAS SHOW A DIFFERENCE IN THE CHARACTER OF THE NOISE. MUST HAVE HIGH LEVEL OF LUMINANCE TO SEE THE CHROMINANCE EFFECT. IT IS VERY DIFFICULT TO ASSESS THE CHROMINANCE TRANSITIONS, BECAUSE OF THE DISTORTIONS ON "A". THE NOISE ON THE "B" IS MORE OBVIOUSLY PATTERNED. "A" = ORIGINAL "B" = RECORDED *(observations apply to all images, except where noted)*	
Columns		
Tulips		
Sculptures		
Toys		
Girl with Toys		
Memorial Arch		
Woman with Roses		
Window		
FAX machine		
Paint Store		
Mannequins		
Living Room		
Park Ride		
Woman & Room		
Lamp		
Co-Channel		
Rotating Pyramids		

Comments:

1. ADDITIONAL ARTIFACTS NOTED MAY WELL BE DUE TO ADDITIONAL CODE/DECODE PROCESS, DIFFERENT TYPES OF CODERS AND DECODERS MAY CAUSE SIGNIFICANTLY DIFFERENT ARTIFACTS.*

2. IF MATERIAL IS TWO FIELD EDITED, SIGNIFICANTLY DIFFERENT ARTIFACTS COULD OCCUR DUE TO DIFFERENT CODERS/DECODERS.

** Expresses concern by expert observers that differences were seen in D2 recording compared to source, but no differences were seen in Digital Betacam recording. However, experts were inadvertently led to believe that plant distribution of NTSC video at ATTC was component, not composite.*

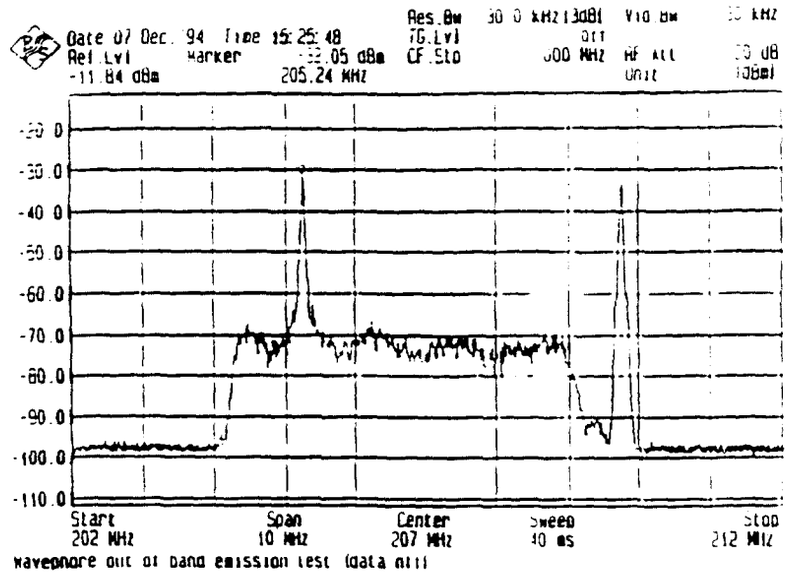
Expert Observation & Commentary

Date of Test: 12/6/94 Start Time 6:00 PM

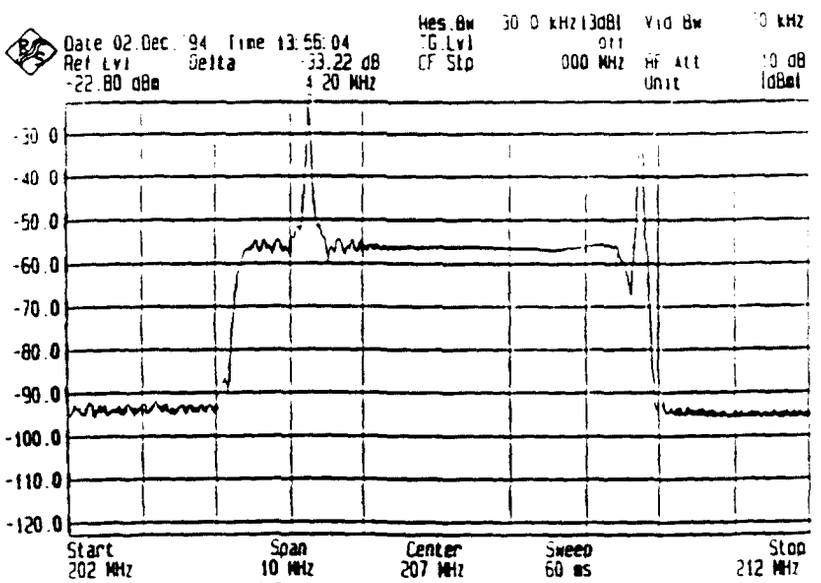
NTSC+ recording versus reference NTSC recording on VHS	
Video Images	Observations
Metal Table and Chairs	no change
Vines	" "
Wavy Wall	" "
Columns	" "
Tulips	bleeding of chroma
Sculptures	
Toys	
Girl with Toys	
Memorial Arch	
Woman with Roses	chroma shift
Window	
FAX machine	slightly less readability of text
Paint Store	
Mannequins	slight chroma shift
Living Room	
Park Ride	slight chroma shift
Woman & Room	green smear
Lamp	
Co-Channel	graph (*on the back wall has*) chroma shift
Rotating Pyramids	red/green smear

Date of Test: 12/6/94 Start Time 6:10 PM

NTSC+ recording versus reference NTSC recording on VHS	
Audio Sounds	Observations
Male Speech	OK
Glockenspiel	OK
Silence	OK
Haydn Trumpet	OK
Tracy Chapman	OK
Bass Guitar	OK

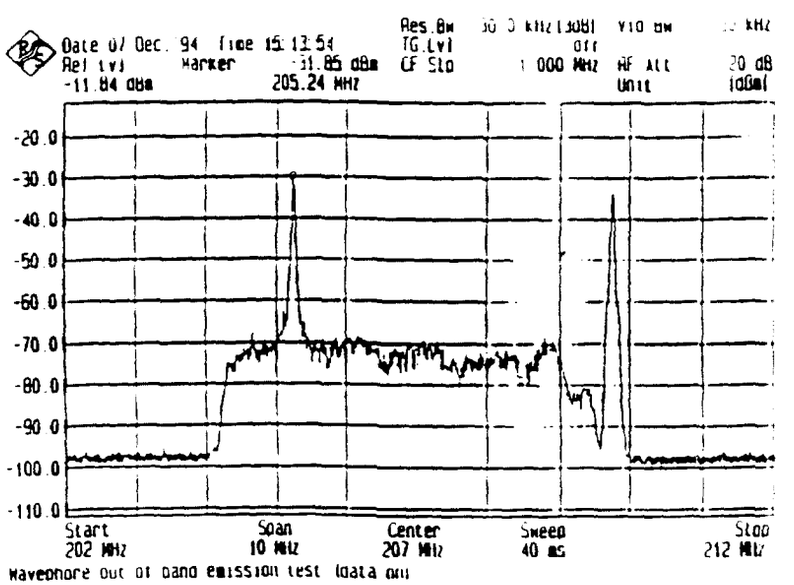


Out-of-Band Emissions
Data OFF 15:25:48



NTSC Reference, Ref

Out-of-Band Emissions
REFERENCE 13:56:04 (2-Dec-94



Out-of-Band Emissions
Data ON 15:13:54

OTHER TESTS

Digideck System

National Data Broadcasting Committee

NATIONAL DATA BROADCASTING COMMITTEE

DIGIDECK TEST RESULTS

NDBC Test Plan ¶	Description	Result
2.1	Transmitted Bit Rate	525 kbps
3.6	Real-Time Delay (Latency)	12 msec
3.7	Acquisition Time (Method 1)	1.25 sec
3.1.3	Proper Decoding of Closed Captioning	OK

NATIONAL DATA BROADCASTING COMMITTEE
DIGIDECK RECORDABILITY TEST

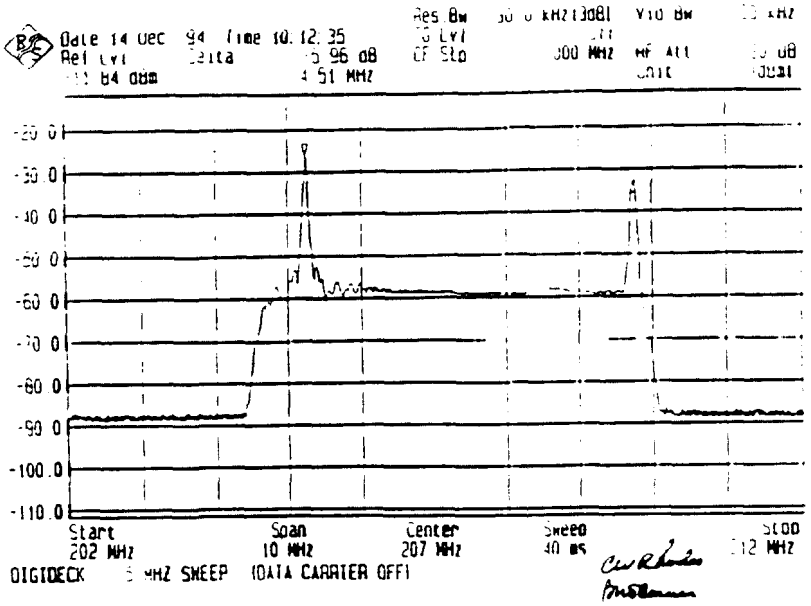
Expert Observation & Commentary

Date of Test: 12/16/94 Start Time 2:20 PM

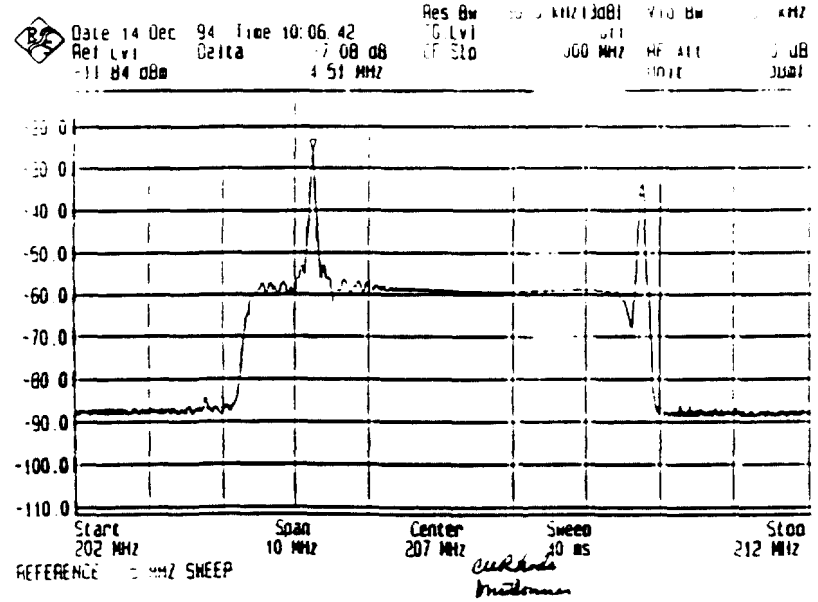
NTSC+ recording versus reference NTSC recording on VHS	
Video Images	**Observations**
Metal Table and Chairs	SOME INCREASE IN BACKGROUND NOISE
Vines	*(applies to all images)*
Wavy Wall	
Columns	
Tulips	
Sculptures	
Toys	
Girl with Toys	
Memorial Arch	
Woman with Roses	
Window	
FAX machine	
Paint Store	
Mannequins	
Living Room	
Park Ride	
Woman & Room	
Lamp	
Co-Channel	
Rotating Pyramids	

Date of Test: 12/16/94 Start Time 2:45 PM

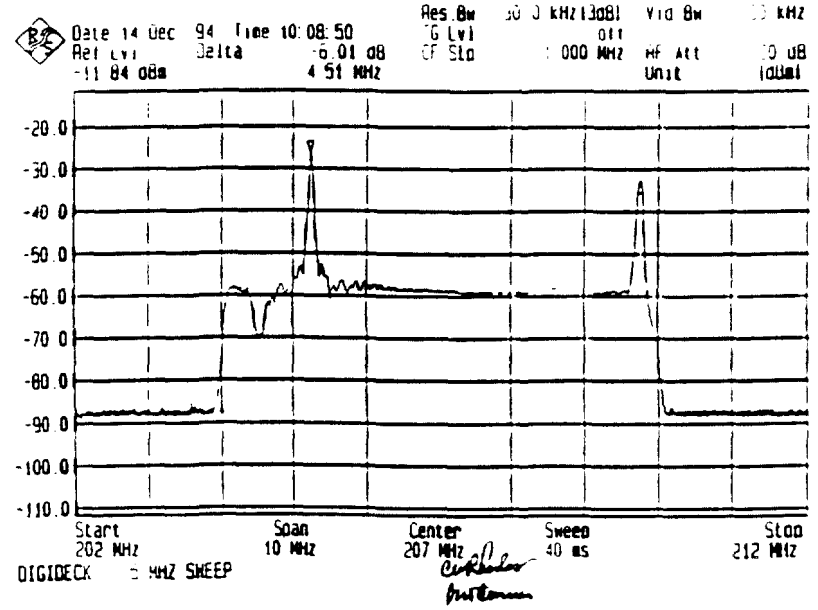
NTSC+ recording versus reference NTSC recording on VHS	
Audio Sounds	**Observations**
Male Speech Glockenspiel Silence Haydn Trumpet Tracy Chapman Bass Guitar	NO DIFFERENCE NOTED IN AUDIO. HOWEVER, THE NATURE OF THE NOISE IN THE VIDEO DURING THE TEST SEQUENCE WAS DIFFERENT THAN DURING REFERENCE. THERE WAS SLIGHTLY MORE NOISE AND MAY HAVE EXHIBITED A LOW FREQUENCY CHARACTERISTIC TO IT IN THE TEST SEQUENCE. OBSERVING GRAY WHILE LISTENING TO THE AUDIO.



Out-of-Band Emissions
Data OFF 10:12:35



Out-of-Band Emissions
REFERENCE 10:06:42



Out-of-Band Emissions
Data ON 10:08:50

3.1.2 Out-of-Band Emissions Test

REPORT ON THE LABORATORY TEST RESULTS

Presented by the

Evaluation Working Group

to the

National Data Broadcasting Committee

10 March 1995

REPORT ON LABORATORY TEST RESULTS
EVALUATION WORKING GROUP
NATIONAL DATA BROADCASTING COMMITTEE
10 March 1995

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1-INTRODUCTION

This document presents an evaluation of the results of the laboratory test of the data broadcasting systems (NTSC+) that were submitted to the NDBC by Digideck and WavePhore. The tests were conducted at the ATTC and the entire body of test results was presented to the NDBC Evaluation Working Group. This report contains the key results of the testing and same comments by the group that may be helpful to the NDBC committee in their further work. The comments are listed in the same order as the one used in the Summary of Laboratory Test Results (attached). This report should be read in parallel with the "Results of Tests on WavePhore and Digideck Systems, January 26, 1995 document" (see page numbers in the parenthesis next to each criteria) and the notes from the proponents found in Annex 1.

2-EVALUATION CRITERIA

1. Transmitted Bit Rate

The transmitted bit rates were not measured in the tests as they are internal to the systems. The more useful, Net Bit Rates, are given below.

Digideck stated that the transmitted bit rate for their system was a contunuous 700 kilobits/second. WavePhore stated a transmitted burst bit rate of 599 kilobits/second.

2. Net Bit Rate (pp. 82,87)

The net (useful) bit rates measured at the output of the modems, are 525 kbps for Digideck and 384 kbps for WavePhore.

3. Out of Channel Emission (pp 85,89)

RF spectrum plots recorded from analyzer were done for both the NTSC+ signal and the conventional NTSC to compare their out-of-channel emission. The spectrum plots can be found on pages 1 and 2 in Annex 2.

In the case of Digideck, the out-of-channel emission measurement reflects the performance of the proponent-furnished exciter, which was an integral part of the system

submitted for testing. In the case of WavePhore, the proponent-furnished equipment provided a baseband video output to the external exciter furnished by the Test Center. Note that this out-of-channel emission test provided spectral density plots of exciter performance only, which may not reflect the performance of an entire transmitter.

The FCC apparently does not have a mask for out-of-channel emissions of TV broadcast transmitters. Instead, they specify that the required attenuation of the vestigal lower sideband must be at least 20 dB down from the upper sideband at the lower channel edge which is 1.25 MHz below the picture carrier. In addition, the vestigal sideband must be at least 42 dB below the upper sideband in a notched region 3.58 MHz below the picture carrier. EIA Standard 508 "Electrical Performance Standards for Television Broadcast Transmitters" gives the standard method for making these measurements.

Using the EIA 508 Test Signal and calculating the allowable peak sideband energy referred to the picture carrier at band edge gives a value of -40.56 dB. Both the WavePhore system at -68 dB and the Digideck system at -45 dB are less than this value and would thus seem to be acceptable, as this is less out-of-channel energy than would be generated by televising a scene having lots of low frequency detail. The calculated allowable peak energy 3.58 MHz below the carrier referred to peak carrier is -62.56 dB. Here again, the WavePhore system at -68 dB and the Digideck system at -63 dB would seem to be acceptable. However the WavePhore system exhibited a 5 dB advantage notwithstanding the resolution of the out-of-band emission question.

Assuming that the peak signal out-of-channel emission allowance for the upper channel edge would be the same as for the lower, then WavePhore at -68 dB and Digideck at -50 dB referred to peak carrier are safely within the requirements. However the WavePhore system exhibited an 18 dB advantage notwithstanding the resolution of the out-of-band question.

It should be noted that the ATTC made the above measurements with a spectrum analyzer having a 30 kHz resolution bandwidth in the peak hold mode. If a narrower filter had been used, such as the frequency selective volt meter suggested in the EIA standard, it would be expected that the Digideck out-of-channel emissions would be several dB lower due to the noise-like spectral spreading of the data carrier.

Although the FCC did not anticipate digital data transmission when they established TV broadcast transmission rules, it would seem that neither WavePhore nor Digideck would cause any more adjacent channel interference to other services or TV stations than a normal TV transmission meeting the FCC requirements.

4. Coverage

No specific tests were done to measure the coverage of the systems but results under items 9, 10 and 12, interference and immunity to noise may be useful to determine it.

5. NTSC Degradation (Video)

Subjective Tests (pp. 67-78)

These tests were intended to subjectively characterize the degradation of the host NTSC signal as a result of the additional data signal. Two expert observers were asked to rate twice, 3 different sequences on 16 different receivers. For rating, the 5 level CCIR impairment scale was used:

5 - Imperceptible
4 - Perceptible but not annoying
3 - Slightly annoying
2 - Annoying
1 - Very annoying

The tests were done both with the Data On and Off. The results with the Data Off do not represent a normal mode of operation and should not be used to evaluate the performance of the systems. They may be useful however for the systems' designers.

The following table contains the average rating of each of the two viewers for the 16 receivers and for each of the 3 pictures: #1 Mannequin, #2 Toys and #3 Memorial Arch.

TABLE: 1: Video Quality Test (Data ON)

	DIGIDECK		WAVEPHORE	
DATA ON				
	Observer #1	Observer #2	Observer #1	Observer #2
Weak Level				
Image #1	5.0	4.9	3.6	4.2
Image #2	5.0	4.9	4.5	4.3
Image #3	4.9	4.9	4.6	4.5
Strong Level				
Image #1	5.0	4.4	3.5	3.9
Image #2	5.0	4.5	4.4	4.2
Image #3	5.0	4.5	4.5	4.3

TABLE 2: Video Quality Tests (Data OFF)

	DIGIDECK		WAVEPHORE	
DATA OFF				
	Observer #1	Observer #2	Observer #1	Observer #2
Weak Level				
Image #1	5.0	5.0	3.4	4.3
Image #2	5.0	5.0	4.4	4.1
Image #3	5.0	5.0	4.5	4.5
Strong Level				
Image #1	5.0	5.0	3.5	4.3
Image #2	5.0	5.0	4.4	4.3
Image #3	5.0	5.0	4.5	4.7

For the Digideck system the average degradation was Imperceptible (5) except for the rating by Observer #2 for the Strong Level signal with the Data ON when the average degradation was rated between Imperceptible (5) and Perceptible but not Annoying (4).

For the WavePhore system the average degradation was between Imperceptible (5) and Perceptible but Not Annoying (4) except for the rating by Observer #1 with Image #1 (Mannequin) for which the average degradation was rated between Perceptible but not Annoying (4) and Slightly Annoying (3).

Any ratings at the Weak level which are higher than the corresponding ratings at the Strong level indicate that the increased receiver noise at the Weak level had a masking effect upon the impairment introduced by the system under test. Any degradation under the Data On condition, relative to the Data Off condition indicates the extent to which the data signal itself was responsible for the degradation.

The above results showed that, under specific laboratory conditions, the system from Digideck introduced less picture degradation than the one from WavePhore. Readers are cautioned however that such limited tests, only 2 viewers and 3 images selected to stresss the systems, should not be considered conclusive and exhaustive results.

Ghost Cancellation Operation (pp. 29,45)

Subjective tests were also done to determine if the operation of an NTSC Ghost Canceller would be affected by the addition of the data signal. The tests were repeated for both the Ghost canceller ON and OFF conditions.

For Digideck the tests indicate that the Data Broadcasting systems did not affect the operation of the ghost canceller. For WavePhore the results from the 2 expert observers were too different to be useful to reach a conclusion. The Evaluation Working Group believes, however, that the system from WavePhore should not affect the operation of the ghost canceller as no data is inserted during the VBI. the time when the Ghost Cancelling Reference signal is transmitted.

Unweighted Signal-to-Noise Ratio Measurement

The unweighted signal-to-noise ratio was measured on a VBI line. For the WavePhore system, no data is inserted during the VBI lines. Therefore, the S/N measurement of the WavePhore system is identical for both the data ON or OFF conditions as no measurements were done during the active picture.

For the Digideck system, data is inserted continuously. Therefore, the S/N measurement with data ON is influenced by the data energy and consequently is lower than the S/N measurement with data OFF.

Therefore the unweighted S/N measurement should not be used to compare the performances of the WavePhore system and the Digideck system. However, the noise spectrum measurement can be used to evaluate the system performance with data ON since it uses the active line with data ON. These plots can be found on pages 3 and 4 in Annex 2. These plots show that neither system imposes significant luminance noise penalty.

2T K Factor Measurement

Both systems performed very well on this test. Due to the different IF modulators employed, a direct comparison between the systems should not be made. It should be noted that the voltage value of the 2T pulse signal at 2 MHz is 6 dB down and more than 40 dB down at 4 MHz from the peak value. Therefore the 2T pulse signal could not measure any distortion of the high frequency components, such as the chroma components.

Luminance Non-linearity Measurement

Both systems performed well and within the specification for this test. Due to the different IF modulators employed, a direct comparison between the systems should not be made.

Gain and Group Delay Measurement

The gain and group delay measurements (data ON) show that the frequency response of the WavePhore system is attenuated 1 dB at 3.62 MHz, 2 dB at 3.66 MHz and 3 dB at 3.69 MHz, respectively (based on scaling of the plot dated Nov. 29, 1994 @ 13:58:30, p.

5 in Annex 2). This indicates that the filtering in the WavePhore system results in significant loss of upper sideband components of the chroma signal, which could cause chroma crosstalk and loss of color saturation. Subjectively, the chroma crosstalk might be visible in horizontal transitions. The peak-to-peak group delay of the WavePhore system exceeds 350 nsecs (4.18 MHz bandwidth).

The gain and group delay measurement (data ON) show that the frequency response of the Digideck system is attenuated 1 dB at 3.76 MHz, 2 dB at 4.0 MHz and 3 dB at 4.06 MHz, respectively (based on scaling of the plot dated Dec. 14, 1994 @ 14:07:50, p. 6 of Annex 2). The peak-to-peak group delay of the Digideck system is about 80 nsecs (4.18 MHz bandwidth).

Multiburst Measurement

The multiburst measurement is not a good method to measure the frequency response through the transmission system due to the sharp cut-off filtering. The upper sideband of the 4.1 MHz burst cannot pass through the modulator and demodulator. Also, the multiburst measurement does not provide any group delay information which is as important as the gain/frequency measurement.

The multiburst performance of the WavePhore system could not provide meaningful information because part of the test signal energy was removed and the modulated data was inserted between 3.9 and 4.2 MHz by the system.

The performance of the Digideck system on the multiburst signal is very close to the reference.

12.5T Chrominance/Luminance Gain and Delay Measurement

The chroma gain of the WavePhore system is approximately 72%, about a 3 dB loss in color saturation. The chroma gain of the reference (same exciter) was approximately 102%.

The chroma gain of the Digideck system is approximately 92%. The chroma gain of the reference (different exciter) was approximately 93%.

The chroma delay of the Digideck system measured approximately 25 nsecs. The chroma delay of the WavePhore system measured approximately 66 nsecs. However, the 12.5T measurement technique assumes that the delay across the chroma bandpass is constant, a condition more closely met by the Digideck system than by the WavePhore system.

NTSC *Recordability (pp. 83,84,88)*

For the WavePhore system, recordings were made of the NTSC+ signal on two professional recorders, a Digital Betacam and a D2. the recorded NTSC+ signals were compared by expert observers with the "live" output of the NTSC+ encoder. No difference was noticed on the Betacam recording or on two predominately monochrome images on the D2 recording. On the remaining images recorded on the D2, the observers noted a difference in the character of the noise (more obviously patterned; they may well be NTSC encoding artifacts) in flat colored areas having a high luminance level. The observers found it very difficult to assess any differences in chrominance transitions because of the distortions present on the "live" output.

The same recordings were used for the Data Recordability test (see section 29 on page 12).

For both systems, recordings were made of the NTSC+ signals (at RF) on a consumer VHS recorder. The recorded NTSC+ signals were compared by expert observers with recorded NTSC signals. For the WavePhore system, chroma shift, bleeding, and smear were noted on the NTSC+ recording, relative to the reference NTSC recording. For the Digideck system, some increase in background noise was observed on the NTSC+ recording.

6. NTSC Degradation (Audio) (pp. 72,73,79,80)

These tests were intended to subjectively characterize the degradation to the host NTSC audio as a result of the additional data signal. Two observers were asked to rate twice 3 different sounds on 6 different receivers (#1 Male Speech, #2 Glockenspiel, #3 Silence). The 5 level CCIR impairment scale was used (see page 3).

The tests were done both for the Data On and Off. The results with the Data Off do not represent a normal mode of operation and should not be used to evaluate the performance of the systems. They may however be useful for systems' designers.

For most tests both systems created no or very little (rating 5 to 4.5) perceptible degradation to the sound quality.

The following table contains the average rating of each of the two observers for the 6 receivers and for each of the 3 sounds.

TABLE 3: Audio Quality Tests (Data ON)

	DIGIDECK		WAVEPHORE	
DATA ON				
	Observer #1	Observer #2	Observer #1	Observer #2
Weak Level				
Sound #1	5.0	5.0	5.0	5.0
Sound #2	4.5	4.8	5.0	4.9
Sound #3	5.0	5.0	4.9	5.0
Strong Level				
Sound #1	4.9	5.0	4.9	5.0
Sound #2	4.6	4.9	5.0	5.0
Sound #3	5.0	5.0	4.9	5.0

The above results showed that the system for WavePhore introduced less audio degradation than the one from Digideck.

In particular on one test, the Digideck system degraded the sound quality more (Rating 2 to 3.5) on one of the six receivers: Observer #1 with Sound, #2 Glockenspiel on receiver B1).

Readers are cautioned however that such limited test, only 2 observers and 3 sounds selected to stress the systems, should not be considered conclusive and exhaustive results.

9. Co-channel Interference (pp 12,32)

The level of interference at the threshold of visibility (TOV) was determined for both NTSC+ and conventional NTSC in order to determine if there was a difference.

The results show that the co-channel interference to the video created by both NTSC+ systems is the same as that created by conventional NTSC.

Tests were also done for stereo audio and, as for conventional NTSC, the sound was more robust than the video.

10. Adjacent Channel Interference (pp 12,32)

The level of interference at the threshold of visibility (TOV) was determined for both the NTSC+ and conventional NTSC in order to determine if there was a difference.

The results show that the upper adjacent channel interference created by both systems is the same as that created by conventional NTSC.

Lower adjacent channel interference is lower than the one created by conventional NTSC by 2.28 dB for Digideck and by 0.95 dB by WavePhore. These differences are not significant considering the subjective nature of the test.

Tests were also done for stereo audio and, as for conventional NTSC, the sound was more robust than the video.

11. Bit Error Rate Performance

The bit error rate performance of both systems was measured against random noise, impulsive noise, multipath, adjacent and co-channel interference. The results are given in sections 12, 13, 14, 15, and 16).

12. Immunity to Noise

Random Noise (pp 13,33)

The level of noise for a BER of 10^{-5} was measured. Furthermore the BER for +2, and +1 dB above, and -2 and -1 dB below the noise level creating a BER of 10^{-5} was also measured.

Both systems behaved as expected by exhibiting a cliff effect around the threshold. The carrier to noise ratio, measured over a 6 MHz bandwidth, for a BER=10^{-5} was 28 dB for Digideck and 44 dB for WavePhore. The difference of 16 dB in favor of Digideck is significant.

Impulse Noise (pp 27,43)

The BER was measured for both systems for the same 5 levels of impulse noise. These levels were subjectively equally spaced between the threshold of visibility (TOV) and the point of unusuability (POU) as seen on half of the representative NTSC receivers.

With these levels of impulse noise, Digideck exhibited a substantially better immunity to impulsive noise as no errors were detected for any of the levels. Errors or synchronization problems (NO SYNC) were observed by the bit error rate meter for the WavePhore decoder at all of these levels of impulse noise.

A report of "NO SYNC" in the BER test results corresponds to the "Sync Loss" alarm having been asserted by the HP3784A BER meter. According to the instruction manual for this instrument, "Sync Loss" indicates that the receiver in the HP instrument has lost

reference pattern synchronization. The criteria for sync loss is Error Ratio $\geq \frac{1}{9}$ and sync gain is Error Ratio $\leq \frac{1}{100}$.

Our understanding of this is that the "sync loss" indicator exhibits hysteresis between a BER of approximately 10^{-1} and 10^{-2}. When the indication is asserted, the BER is greater than 10^{-2}(>1E-02); i.e., there is more than one error per 100 bits transmitted.

13. Immunity to Co-channel Interference (pp 12,32)

These tests were done to determine the robustness of each system to interference from a conventional NTSC or NTSC+ co-channel. The level of the interference was recorded when a BER of 10^{-5} was measured.

A significant difference in the performance of the systems was found in the co-channel interference test. The system from Digideck exhibited a 12 dB better immunity to co-channel interference. The results have also shown the effect of the WavePhore system adaptive equalizer: the results improved the longer the interference is present.

14. Immunity to Adjacent Channel Interference (pp 12,32)

These tests were done to determine the robustness of each system to interference from a conventional NTSC or NTSC+ adjacent channel. The level of the interference was recorded when a BER of 10^{-5} was measured.

The system from Digideck exhibited a better immunity of about 20 dB to adjacent channel interference. The WavePhore system had a BER of 10^{-5} at about the level of adjacent channel interference that is perceptible in a conventional NTSC transmission.

15-16. Immunity to Multipath (pp 28,44)

The bit error rates of each system were measured to determine their robustness to 4 typical combinations of multipath (the phase of the multipath in combination 3 was changing with time at a rate of 2 Hz):

Ensemble	Delay (microsec)	Attenuation (dB)	Phase (degrees)
1	0.1,1,6,20	-3,-12,-17,-14	-18,314,40,75
2	0.2,1.9,3.9,8.2	-14,-18,-24,-22	350,50,0,55
3	1	-14	360 degree in .5 sec.

			(2 Hz Rate)
4	-0.7,0.1,-0,4	-28,-10,-30	30,240,240

The system from Digideck exhibited a significantly better immunity to multipath as no errors were detected for any combination. For the system from WavePhore each multipath combination created errors or a No Sync indication (see description of this condition in section 12) on the bit error rate meter.

18. Real-Time Delay (latency) (pp 82,87)

The real-time delay was 12 milliseconds for Digideck and 57 milliseconds for WavePhore.

19. Acquisition Time (pp 82,87)

Acquisition time was 1.0 second for WavePhore and 1.25 second for Digideck.

23. Interference to HDTV

No test was specified to determine the level of interference created by NTSC+ into a future HDTV signal.

24. Interference from HDTV

No test was specified to determine the level of interference future HDTV signal into NTSC+.

29. Data Recordability

No data was recovered from a recording of the WavePhore system made on a D2 and a Digital/Betacam.

No professional format recordings were made of the Digideck signal, since the Digideck system does not provide a baseband encoded signal and no claim of Data Recordability was made by the proponent.

3. COMPATIBILITY OF OPERATION

No test was specified to determine if both systems could operate simultaneously on the same NTSC transmission.

4. CONCLUSIONS AND RECOMMENDATIONS

The results of the laboratory tests seem to show that neither system created more adjacent or co-channel interference to NTSC than a conventional NTSC signal. Note that this out-of-channel test may not reflect the performance of an entire transmitter.

The results of the quality tests showed that the system from Digideck did not create perceptible degradation except for a few tests for which the degradation was rated between Imperceptible (5) and Perceptible but Not Annoying (4). The results of the quality tests showed that the system from WavePhore created degradation between Imperceptible (5) and Perceptible but Not Annoying (4) except for a few tests for which the degradation was rated between Perceptible but Not Annoying (4) and Slightly Annoying (3). These results showed that the system from Digideck introduced less picture degradation than the one from WavePhore. Readers are cautioned however that such limited tests, 2 viewers and 3 images, should not be considered as to be conclusive and exhaustive results.

The system from Digideck exhibited much better robustness to all tested impairments (random noise, impulse noise, multipath, adjacent and co-channel interference) than the system from WavePhore.

Some issues have been suggested for further consideration by the NDBC:

- out of band emission for a transmitter;
- coverage studies;
- NTSC degradation (video and audio);
- upper-adjacent channel interference to NTSC audio (SAP and PRO);
- interference to and from HDTV signals;
- compatibility of operation of the 2 data broadcasting systems;
- translator operation.

Field tests are recommended to supplement the laboratory tests and to confirm that operation and performance in the field are as expected from the laboratory test results.

Based on the overall superiority of the laboratory test results obtained by the Digideck system, there is a consensus that this system should be tested in the field.

There is an unresolved question about whether the WavePhore system should be tested in the field. The NDBC has the three following options (listed without preference):

1. To test both systems in the field.

2. To test the WavePhore system in the field, only if both systems can be tested at the same time without significant logistic problems or supplementary cost.

3. . To test the WavePhore system in the field if the Digideck system does not perform as well as expected from the results of the laboratory tests.

In any case, the NDBC should consider the merits and implications of permitting the proponent to implement improvements to their systems for the field test. The Evaluation Working Group notes that such equipment modification may negate the laboratory test results.

Summary of Laboratory Test Results
Evaluation Working Group-National Data Broadcasting Committee
Draft dated 9-3-95

	Main Criteria	Priority	Results Pages	Units	Test Plan	Digideck	Wave Phore
1	Transmitted Bit Rate	M		kbps		700	599
2	Net Bit Rate	H		kbps		525	384
3	Out-Of-Channel Emissions	H	89,85		3.1.2	See ATTC results p.89	See ATTC results p.85
4	Coverage	H					
5	NTSC Degradation (Video)	H		rating	3.1.1		
5a	Weak Desired Signal Data ON		75,68			See ATTC results p.75	See ATTC results p.68
	Data OFF		76,69			See ATTC results p.76	See ATTC results p.69
	Strong Desired Signal Data ON		77,70			See ATTC results p.77	See ATTC results p.70
	Data OFF		78,71			See ATTC results p.78	See ATTC results p.71
5b	Effect of Multipath			rating	3.4		
	Ghost Cancelling ON		45,29			See ATTC results p.45	See ATTC results p.29
	Ghost Cancelling OFF		45,29			See ATTC results p.45	See ATTC results p.29
5c	Unweighted SNR (@ -26 dBm)		59,49	dB			
	Data OFF					52.7	53.7
	Reference					54.5	54.8
	Data ON					46.2	53.7
5d	VM-700 Measurements		47,66			See ATTC results p.57-66	See ATTC results p.47-56
5e	Recordability		88,83-84			See ATTC results p.88	See ATTC results p.83-84
6	NTSC Degradation (Audio)	H		rating	3.1.1		
	Weak Desired Signal Data ON		79,72			See ATTC results p.79	See ATTC results p.72
	Data OFF		79,72			See ATTC results p.79	See ATTC results p.72
	Strong Desired Signal Data ON		80,73			See ATTC results p.80	See ATTC results p.73
	Data OFF		81,83			See ATTC results p.81	See ATTC results p.83
	Effect of Multipath			rating	3.4		
	Ghost Cancelling OFF		46-30			See ATTC results p.46	See ATTC results p.30
7	Closed Caption Interference	H				OK	OK
8	Existing VBI Signal Interference	M			3.1.3		
9	Co-Channel Interference	H		dB	3.2.1		
	NTSC + Data into NTSC		32-12			41.84	40.22
	NTSC into NTSC		32-12			41.58	40.28
	Audio		40-24			see ATTC Summary p.40	see ATTC Summary p.24
10	Adjacent Channel Interference	H		dB	3.2.2		
	Video Upper NTSC + Data into NTSC		32-12			-7.24	-8.02
	Upper NTSC into NTSC		32-12			-7.29	-8.26
	Lower NTSC + Data into NTSC		32-12			6.01	5.01
	Lower NTSC into NTSC		32-12			8.29	5.96
	Audio					see ATTC Summary p.40	see ATTC Summary p.24
11	Bit Error Rate Performance	H				See Item 12	See Item 12
12	Immunity To Noise	M	33-13		3.3.1		
12a	Random Noise into NTSC + Data						
	+2 dB			BER		4.03E-3, 3.93E-3, 4.01E-2	1E-4, 1.62E-3, 9.07E?
	+1dB			BER		2.22E-5, 2.68E-5, 2.95E-5	2.44E-5, 1.66E-5, 2.49E-5
	Threshold 0			BER		0	0
	-1dB			BER		0	0
	-2 dB			BER		0	0
	Threshold			dB		28.08	44.23

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	Criteria	Priority	Results Pages	Units	Test Plan	Digideck	Wave Phore
12b	Impulse Noise into NTSC + Data		43,27	BER	3.3.2		
	Threshold (TOV)					0	3.74E-5, 4.08E-5, 0
	+1					0	No Synch
	+2					0	No Synch
	+3					0	1.983E-1, 1.951E-1, 1.1934E-1
	+4					0	2.687E-1, 2.711E-1, 2.7E-1
	Unusuability (POV)					3.16E-5, 1.65E-5, 2.69E-5	
13	Immunity To Co-Channel Interference	M		dB	3.2.1		
	NTSC into NTSC + Data		34,14			11.87	39.52
	NTSC + Data into NTSC + Data		35,15-16			14.97	35.76, 30.76
14	Immunity To Adjacent Channel Interference	M		dB	3.2.2		
	Upper NTSC into NTSC + Data		36,17-20			-35.14	-1.86, -1.86, -6.86, -8.86
	Upper NTSC + Data into NTSC + Data		37,21			-34.9	-9.98
	Lower NTSC into NTSC + Data		38,22			-21.98	-1.95
	Lower NTSC + Data into NTSC + Data		39,23			-22.09	-1.82
15	Immunity to Static Multipath	M	44,28	BER	3.4		
	Ensemble 1					0	No Synch
	Ensemble 2					0	No Synch, 5.39E-3, No Synch
	Ensemble 4					0	0, 2.18E-5, 0
16	Immunity to Dynamic Multipath	M-H	44,28	BER	3.4		
	Ensemble 3					0	3.302E-4, 2.992E-4, 0
17	Error Correction Performance	M					
18	Real-time Delay	L		milli sec		12	57
19	Acquisition Time	L		sec		1.25	1
20	Framing	L					
	Additional Criteria					Proponent's Specification	
21	Two-way Capability	M				no	dial-up
22	Interference to Ghost Cancellation	M				no	no
23	Interference to HDTV	M				co-channel	no
24	Interference from HDTV	L				co-channel	no
25	Cost Of The Receiver	M-H		$		25 (chip only)	300
26	Cost Of The Encoder	L		$			
27	Co-Existence With Scrambling	M				depends	some systems
28	Co-Existence With Compression	M				depends	no
29	Data Recordability (Commercial)	L				no	yes
30	Data Recordability (Consumer)	M				no	no
31	Limitations On Transmit Protocol	M					
32	Changes To NTSC Transmission Systems	H				spectrum shaping	flat spectrum

Annex 1: Proponents' Notes